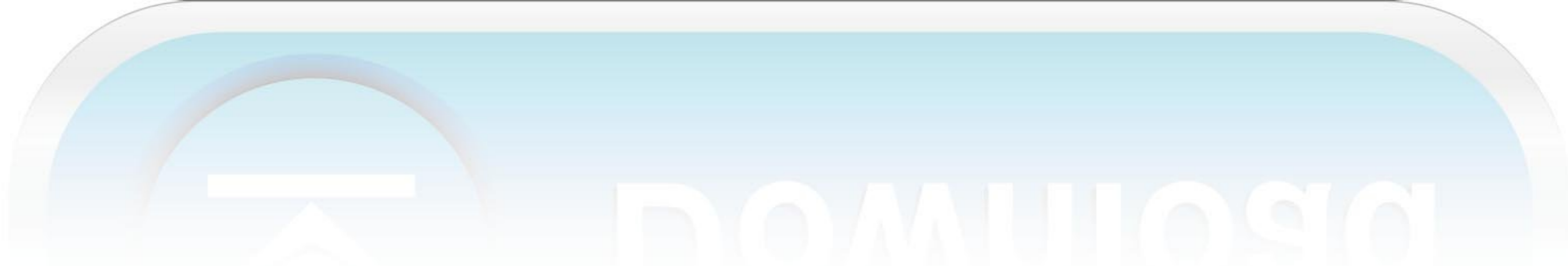




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3.31

Дано: $r = 0,1 \text{ м}$
 $q = 1 \text{ нКл/м}$
 $x = 0,1 \text{ м}$
 $\varphi(x), E_x(x)$
 $|x| \gg r$

Решение:
 Пусть элемент

R - радиусом

$\sigma = \frac{dq}{ds} = \frac{q}{s} = \frac{q}{\pi r^2}$

$d\varphi = k \frac{dq}{R} = \frac{\sigma \pi r^2 dr}{4\pi \epsilon_0 \sqrt{x^2 + r^2}} \rightarrow d\varphi$

$\varphi = \int_0^x \frac{\sigma}{2\epsilon_0} \frac{r dr}{\sqrt{x^2 + r^2}} = \frac{\sigma}{4\epsilon_0} \int_0^x \frac{d(x^2 + r^2)}{\sqrt{x^2 + r^2}}$

$= \frac{\sigma}{2\epsilon_0} \sqrt{x^2 + r^2} - \frac{\sigma}{2\epsilon_0} x = \frac{\sigma}{2\epsilon_0} (\sqrt{x^2 + r^2} - \sqrt{x^2}) =$

$= \frac{q}{2\pi r^2 \epsilon_0} (\sqrt{x^2 + r^2} - \sqrt{x^2}) = \frac{10^{-6} \cdot 1}{2 \cdot 3,14 \cdot 0,1^2 \cdot 8,85 \cdot 10^{-12}} (\sqrt{0,1^2 + 0,1^2} - 0,1) =$

$\approx 45 \text{ В}$

$E_x = -\frac{\partial \varphi}{\partial x} = -\frac{q}{2\pi r^2 \epsilon_0} \left(\frac{x}{\sqrt{x^2 + r^2}} - \frac{x}{\sqrt{x^2}} \right) =$

$= \frac{q}{2\pi r^2 \epsilon_0} \left(\frac{x}{\sqrt{x^2}} - \frac{x}{\sqrt{x^2 + r^2}} \right) =$

$= \frac{10^{-6} \cdot 1}{2 \cdot 3,14 \cdot 0,1^2 \cdot 8,85 \cdot 10^{-12}} \left[1 - \frac{0,1 \text{ м}}{\sqrt{0,1^2 + 0,1^2}} \right] \approx 0,53 \text{ В/м}$

Элемент элемента (на рисунке φ)

$ds = r d\theta dr$

$d\varphi = \frac{k dq}{r}$ $r = \sqrt{x^2 + r^2}$

$d\varphi = \frac{q}{\pi r^2} r d\theta dr$

$d\varphi = \frac{kq}{\pi r^2} = \frac{rd\theta dr}{\sqrt{x^2 + r^2}}$

$\varphi = \frac{kq}{\pi r^2} \int d\theta \int \frac{r dr}{\sqrt{x^2 + r^2}} = \frac{2\pi kq}{\pi r^2} \frac{1}{2} \cdot 2 \cdot \sqrt{x^2 + r^2} \Big|_0^r$

$= \frac{2kq}{r^2} (\sqrt{x^2 + r^2} - \sqrt{x^2})$

Ответ: $\frac{2kq}{r^2} (\sqrt{x^2 + r^2} - \sqrt{x^2})$

$\frac{q}{2\pi r^2 \epsilon_0} \left(\frac{x}{\sqrt{x^2}} - \frac{x}{\sqrt{x^2 + r^2}} \right)$

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